APPLICATION

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TITLE: **A METHOD FOR GENERATING A DIVERSE SET OF TRAVEL OPTIONS**

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A METHOD FOR GENERATING A DIVERSE SET OF TRAVEL OPTIONS

BACKGROUND

This invention relates to travel planning systems.

Computer travel planning systems such as airline computer reservation systems (E.G., Sabre®, Galileo®, Worldspan®, Amadeus®) used by airline reservation agents, human travel agents, and automated travel agents such as internet web sites Travelocity® and Expedia®, generally produce a relatively small set of recommended travel options for a query that has a route and/or time specification.

For air travel, usually the number of travel options that a travel planning system produces is much smaller than the total set that could possibly satisfy a traveller's request. For example, a CRS may respond to a round-trip query specified by a departure city and date and a return city and date with a set of 10 or so possible flight and fare combinations, even though there may be thousands of combinations of flights that satisfy the request.

In many cases, resource limitations prevent a travel planning system from analyzing or generating more than a small set of travel options. Moreover, for air travel it may be that for each option the system needs to query airlines about seat availability. The availability process places practical limits the number of options that may be considered.

SUMMARY

If a travel planning system is limited in the number of options it can generate, it may be desirable that the travel planning system consider or generate a diverse set of travel options. The planning system can maximize its chance of generating a good option by enforcing diversity in the set of

options generated.

According to an aspect of the present invention, a method for providing a set of travel options includes reducing a larger set of travel options to a smaller set of diverse travel options.

According to an additional aspect of the present invention, a method for reducing a larger set of travel options to a smaller set of diverse travel options includes generating one or more travel options that are best for each of a set of travel preference functions.

According to an additional aspect of the present invention, a method generating a diverse list of N travel options Rts from a larger list of travel options Ts, includes generating a prioritized ordered list of requirements Rs and sorting the list of travel options Ts by an ordering function F to produce a best-first ordered list Ts2 with the list of options being optimized travel options for a set of travel requirements R in accordance with the ordering function F.

According to an additional aspect of the present invention, a travel planning system that outputs a set of travel options smaller than a complete set of travel options that the server has computed by pruning the larger set of options to a smaller set with a diversity-based pruning process.

One or more of the following advantages may be provided by one or more aspects of the invention.

The diversity process in the air travel planning system generates answers on several different airlines, thus the system is capable of satisfying a greater ranger of travellers. Similarly, an air travel planning system that queries airlines about whether there are seats available on a limited number of flights may wish to choose flights at a diversity of flight times, in case flights at particular times of day are all full.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an travel planning system.

FIG. 2 is flow chart of a diversity process for selecting a diverse set of travel options.

FIGS. 3 and 3A are flows chart depicting an example of a diversity process.

FIG. 4 is a flow chart of a process to generate a prioritized list of travel requirements for the diversity process of FIG. 3.

FIG. 5, is a flow chart of an alternative diverstiy process to generate a diverse set of travel options from a larger set of travel options.

DESCRIPTION

Referring now to FIG. 1, a travel planning system 10 is shown. The travel planning system can be used with various forms of travel such as airline, bus and railroad and is particularly adapted for air travel. It includes a server computer 12 having a computer memory or storage media 14 storing a server process 15. The server process includes a scheduler process 16 and a faring process 18. The scheduler process 16 is any suitable scheduler process that will produce from a travel request sets of flights that can satisfy the request. The faring process 18 is a process that determines a set of valid fares, preferrable the faring process 18 links the set of valid fares to the sets of flights to form a pricing solution. The server process 15 can be configured to produce other travel-related information as a result of a user query. For example, the server process 12 can produce routes or airline suggestions, optimal travel times and suggestions for alternative requests.

The travel planning system 10 also includes a plurality of databases 20a, 20b which store industry-standard information

pertaining to travel (e.g., airline, bus, railroad, etc.). For example, database 20a can store the Airline Tariff Publishing Company database of published airline fares and their associated rules, routings and other provisions, the so-called ATPCO database. Database 20b can be an inventory of current availability of airline information for a particular carrier and so forth. The databases 20a-20b are typically stored locally and updated periodically by accessing remote resources 21a, 21b that maintain the respective databases.

The system 10 also includes a plurality of clients 30a-30c implemented by terminals or preferably personal computers. The clients include monitors 40 to display travel options generally through a graphical user interface implemented as a web page, and so forth. The clients 30a-30c are coupled to the server 12 via a network 22 which is also used to couple the remote resources (21a-21c) that supply the databases 20a-20b to the server 12. The network 22 can be any local or wide area network or an arrangement such as the Internet. Typically, in response to a query from a client station, the server 12 will generate a list of travel options. The server or the client or an intermediate computer includes a diversity process to insure that if the list of travel options is relatively long, a diverse set of those travel options will be displayed on the client systems 30. The client can include a client process 36 and is fed a diverse set of travel options from a larger set 26 that is determined by the server 12.

Referring to FIG. 2, a diversity process 50 for selecting a diverse set of travel options from a larger set of candidate travel options is shown. The diversity process includes generating 52 an ordered list of travel requirements that represent conditions possibly required for a travel option to be the best travel option to generate. The diversity process

50 selects 54 for each travel requirement the one or more travel options that satisfy the requirement preferably by choosing those travel options that best satisfy one or more travel preference functions that can be used to order travel options.

For example, the air travel planning system generates the following 10 travel requirements for a set of travel options that each include one or more flights.

1. <none>
2. all flights on American Airlines.
3. all flights on United Airlines.
4. non-stop.
5. departing in morning.
6. departing in evening.
7. non-stop on American Airlines.
8. non-stop on United Airlines.
9. non-stop in morning.
10. non-stop in evening.

The diversity process 50 for each of the requirements the planning system selects 54 from the large set of candidate travel options e.g., the cheapest travel option that satisfies the requirement. The cheapest option is generated; the cheapest options all on American Airlines; the cheapest travel options all on United Airlines; the cheapest travel options that are non-stop; and so forth. These travel options are displayed 56 to provide a traveller a desirable option even if the traveller has restrictions on the times the traveller can travel, or preferences for one airline over another. These options are possible more desireable than if the system had merely generated and sent the 10 cheapest solutions without regard to producing a diverse set of solutions taking into consideration preferences of

the traveller.

Referring to FIG. 3, an example 60 of a diversity process 50 is shown. The diversity process 60 generates a diverse list of travel options from a larger set of travel options. The diversity process iterates through a set of travel requirements and selects the best travel option for each requirement. The diversity process 60 can include an optional process that may improve efficiency in some cases by eliminating more-restrictive travel requirements that are satisfied by solutions selected for less-restrictive travel requirements.

For example, given the ordered travel requirements in the list above, if the cheapest travel option selected for the travel requirement "all flights on American Airlines" happens to be a non-stop option, then the travel requirement "non-stop on American Airlines" is removed from the list of travel requirements to be satisfied, since the same travel option selected for the first requirement will be the best for the second more-specific requirement. This is only applied if the all restrictions in the first requirement are also found in the second requirement.

The diversity process 60 thus includes a procedure for generating a diverse list of (N) travel options (Rts) from a larger list of travel options (Ts), that are the best travel options for a set of travel requirements (R), as defined by an ordering function F. The diversity process 60 generates 62 an prioritized (ordered) list of requirements Rs, and sorts 64 the list of travel options (Ts) by function (F) to produce a best-first ordered list (Ts2). The diversity process 60, initializes the list of result travel options (RTs) to be empty. If the remaining list of requirements (Rs) is empty 6, the process 60 returns an ordered list of diverse travel options (Rts). Otherwise, the diversity process selects 66 the first

travel requirement (R) from the ordered list of requirements (Rs) and removes 68 a requirement (R) from the requirement list (Rs). The diverstiy process 60 find 70 a first (e.g., best) option T in the best-first ordered list (Ts2) that satisfies travel requirement (R).

If no option in the best-first ordered list (Ts2) satisfies 72 the requirement (R), the process 60 goes to check 74 if the remaining list of requirements (Rs) is empty. Otherwise, the diversity process determines 76 if a travel option T is not already in result travel options list (Rts). If the option T is not in the list (Rts), the diversity process adds 78 the travel option T to end of the result travel option list (Rts). If the size of the travel option list (RTs) is equal to or greater than N 80 the process returns the ordered list of diverse travel options.

Referring to FIG. 3A, the diversity process 60 could optionally determine 82 for a travel requirement (R2) in the set of travel requirements (Rs), whether the requirement (R2) is included in a prior requirement (R), and whether the travel option T also satisfies 84 the requirement (R2). If the travel option T satisfies the requirement (R2), the process 60 can remove 86 the requirement R2 from the requirement list (Rs) and return to determine 74 (FIG. 3) if the remaining list of requirements is empty.

Referring to FIG. 4, the process 62 to generate a prioritized list of travel requirements is shown. The list may be a fixed list, for example the list of ten requirements in the example above. Alternatively, the list may be generated taking into account the number of solutions required, the ordering function, and the large set of candidate travel options. For example, the list may be generated 62 by filling 92 in a set of template requirements. A sample set of templates for air travel

is

1. no requirement.
2. all flights on <airline>
3. non-stop.
4. outbound departure in <morning or afternoon or evening>.
5. return departure in <morning or afternoon or evening>.
6. outbound departure date <date>.
7. return departure date <date>.
8. non-stop on <airline>.
9. outbound departure date <date1> and return departure date <date2>.

The large candidate set of travel options may be analyzed 94 to find all parameters e.g., airlines found in any travel option, all departure dates for outbound and return, and all departure parts-of-day (morning, afternoon, evening) for outbound and return. The ordered list of requirements is generated by filling 96 in for each template all airlines, dates and parts-of-day present in the options.

The diversity process 60 can be run more than once with different travel option preference functions (a set of F's). For example, a travel planning system may output a diversity of travel options that include diverse options that are cheap and diverse options that are convenient, reflecting uncertainty in whether a traveller is cost-sensitive or convenience-sensitive.

Referring to FIG. 5, an alternative diversity process 100 to generate a diverse set of travel options from a larger set of travel options is shown. The alternative diversity process 100 generates the best one or more travel options as defined by each of a set of different travel preference functions. The

alternative diversity process 100 defines a set of travel preference functions with each function capable to order travel options. In one example, the set might include "cheapest", "quickest", and "most-convenient" where each is a function that assigns a numerical score to a complete travel option (such as price, total-trip-time, and total trip-time with penalties for stops). Functions that assign numerical values based on combinations of cost and convenience are possible, such as functions that weigh both price and time.

Given set of travel options Ts 101, a set of preference functions Fs, and a desired number of answers for each preference function Ns, the alternative diversity process 100 returns a reduced set of diverse travel options Rts. The alternative diverstiy process initializes 102 a list of result travel options RTs to be empty and for each preference function F in the set of preference functions Fs and number of travel options (N) in the set of desired number of answers in each preference function (Ns), the alternative diversity process 100 computes 104 the N best travel options in Ts as defined by F. For each travel option T, unless the travel option T is in the set of diverse travel options Rts 106 , the alternative diversity process 100 adds 108 the travel option T to the set of diverse travel options Rts checks 110 the number of options. The alternative diversity process 100 outputs 112 the diverse set of travel options (RTs).

Other Embodiments

It is to be understood that while the invention has been described in conjunction with the detailed description thereof, the foregoing description is intended to illustrate and not limit the scope of the invention, which is defined by the scope of the appended claims. Other aspects, advantages, and modifications are within the scope of the following claims. For

example the process could be implemented when pricing solutions are represented in pricing graph.

A computer travel planning system that outputs a diversity of travel options may be built by combining a travel planning system that transmits a larger set of solutions to a second computer system that reduces the set of travel options using diversity procedures as described above.

The large set of candidate travel options is represented as a list. Other representations are possible. For example, the set of travel options may be represented by a data structure that stores a large set of travel options by representing permitted combinations of smaller travel option components such as airline flights and fares. In such cases the travel option selection process above may be implemented using a more complicated operation than searching through an ordered list. With the pricing-graph the process for finding the best travel option that satisfies a travel requirement may be implemented for a representation that expresses travel options in terms of permitted combinations of smaller travel option components by disabling option components inconsistent with the requirement. The process applys an algorithm that extracts the best solution from the pricing graph representation. The diversity process calls an enumeration function, as described above, to enumerate all of the valid pricing solutions from the pricing graph that are remaining after the diversity process selectively invalidated nodes in the graph are are inconsistent with the travel requirements.

What is claimed is: